METHOD AND APPARATUS FOR THREE-DIMENSIONAL COMPOSITIONAL MAPPING OF HETEROGENEOUS MATERIALS

FIELD OF THE INVENTION

[0001] This invention relates to optical instrumentation, and more particularly to a method and apparatus for three-dimensional compositional mapping of heterogeneous materials by laser-ablative sampling combined with optical sensing of sampling positions.

BACKGROUND OF THE INVENTION

[0002] Materials in different stages of transformation from raw material to finished product often present a heterogeneous elemental composition. In particular, an object's surface may be functionalized using one or several layers of varying composition or physical properties. There is a growing need in industry, namely in the context of process development and process control, for at-site high-throughput methods that can reveal the distribution of one or several elements along one or more spatial dimensions.

[0003] Classical analytical techniques have largely focused on the determination of bulk compositions, and few can provide spatially-resolved information. Typically, the material is dissolved and introduced as a solution in the analytical instrument, yielding only average elemental concentrations. Techniques based on an arc/spark do allow direct solid sampling (of electrically conducting materials) without a digestion step. However, they do not possess the capability to provide accurate spatially resolved analyses (Günther et al., Spectrochim. Acta Part B, vol. 54, 1999, p. 381).

[0004] Other techniques, such as Auger or X-ray photoelectron spectrometry, allow the study of surface chemistry on the atomic scale, and can also provide depth-resolved analyses when removing successive layers of material through ion bombardment. In secondary ion mass spectrometry (SIMS), such a bombardment is inherent to the measurement process as the composition at different depths is inferred from the nature of bombardment-induced secondary ions. In order to avoid particle scattering in the gas phase, these and other techniques with similar attributes require working in ultra-high vacuum conditions. Glow-discharge methods